

in the network. This method includes determining if the network node is to be assigned at least one frequency. This method also includes generating a list of eligible frequencies for assignment to the network node based in part on frequency assignments received from at least one neighboring node. This method further includes selecting at least one eligible frequency based at least in part on the received assignments. This method also includes assigning the selected frequency or frequencies to the network node. In certain embodiments, the method includes transmitting a heartbeat message including the assignment of the selected frequency or frequencies to at least the neighboring node.

In certain embodiments listed above, the selected frequency or frequencies are assigned to one or more transceivers. Optionally, two or more transceivers will operate as one or more transceiver teams. In some of the embodiments listed above, the selection of an eligible frequency or frequencies comprises determining benefit values for respective frequencies on the list of eligible frequencies. Optionally, these benefit values are based on at least one of the number of additional nodes the network node will be linked to if the frequency is assigned to the network node and the total number of linked nodes in the network if the frequency is assigned to the network node.

Other aspects and advantages of the invention are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

The system and methods may be better understood from the following illustrative description with reference to the following drawings in which:

FIG. 1 is a conceptual diagram of an ad hoc wireless network;

FIG. 2 depicts components within a network node within the ad hoc wireless network of FIG. 1;

FIG. 3 is a conceptual block diagram of a network node within the ad hoc wireless network of FIG. 1;

FIG. 4 is a flowchart of a method of creating and maintaining frequency channel assignments for a network node in a network, according to an illustrative embodiment of the invention;

FIG. 5 is a flowchart of a method for bootstrapping performed by the network node of FIG. 3, according to an illustrative embodiment of the invention;

FIG. 6 is a depiction of a neighbor-channel list in accordance with an illustrative embodiment of the invention;

FIG. 7 is a flowchart of a method for a steady-state channel assignment and maintenance process performed by the network node of FIG. 3, according to an illustrative embodiment of the invention;

FIG. 8 is a flowchart of a method for determining channel eligibility and benefit performed by the network node of FIG. 3, according to an illustrative embodiment of the invention.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

To provide an overall understanding of the invention, certain illustrative embodiments will now be described, including systems, methods, and software for dynamically and distributively assigning frequency channels in a wireless network. However, it will be understood by one of ordinary skill in the art that the systems, methods and software described herein may be adapted and modified as is appropriate for the application being addressed and that the systems, methods, and software described herein may be

employed in other suitable applications, and that such other additions and modifications will not depart from the scope thereof.

FIG. 1 is a conceptual diagram of an ad hoc wireless network 100, according to an illustrative embodiment of the invention. The general notion of the ad hoc wireless network 100 is well known in the art. In general, the ad hoc network 100 includes a plurality of wireless network nodes (nodes 102-118). These nodes may be mobile, resulting in the topology of the ad hoc wireless network 100 frequently changing. The nodes 102-118 are linked to one another via links 120-136, which may or may not operate on similar frequency channels. Two particular nodes are classified as 1-hop, 2-hop, or X-hop neighbors, where X is an integer, based on the number of links present in the shortest link path between the two nodes. For example, node X (102) has 1-hop neighbors A (104), B (106), and C (108), 2-hop neighbors D (110), E (114), F (116), and H (118), and a 3-hop neighbor G (112). Likewise, node C (108) has 1-hop neighbors X (102) and H (118), 2-hop neighbors A (104) and B (106), 3-hop neighbors D (110), E (114), and F (116), and 4-hop neighbor G (112).

The ad hoc network 100 may also include one or more non-cooperative nodes (e.g., node 140). Non-cooperative nodes do not communicate with the network nodes 102-118, and may not even know of the presence of the nodes 102-118. Non-cooperative nodes operate on one or more frequency channels; for example, non-cooperative node 140 operates on channel 6, denoted as a number within parentheses. Non-cooperative nodes typically have superseding rights to use portions of the spectrum used by the nodes 102-118. For example, non-cooperative nodes may be associated with the primary owner of the spectrum in use. Thus, the network nodes 102-118 are not allowed to assign and must vacate any frequency channel(s) occupied by a non-cooperative node.

The network nodes 102-118 each have one or more links to neighboring nodes, where each link operates on one or more frequency channels. For illustrative purposes, different channels are depicted as different linestyles, as outlined in the legend. For example, in the embodiment illustrated in FIG. 1, node X (102) has a link 120 to node A (104) on channel 1, a link 122 to node B (106) also on channel 1, and a link 124 to node C (108) on channel 4. Similarly, node B (106) shares the link 122 on channel 1 to node X (102), and also has a link 126 to node A (104) on channel 1, a link 130 to node E (114) on channel 2, and a link 132 to node F (116) on channel 2. A link may be established between two 1-hop neighbor nodes if they both have at least one common frequency channel assigned and are within range of each other.

FIG. 2 is a depiction of the components in a wireless network node 200, similar to the wireless nodes 102-118, according to an illustrative embodiment of the invention. In this embodiment, a processor 202 is a central processing unit of a general purpose computer running specialized communications software. In other implementations, the processor 202 may be implemented using one or a combination of a general or special purpose computer, software, and analog or digital integrated circuits, including, without limitation, application specific integrated circuits (ASICs) and digital signal processors (DSPs). The processor 202 is linked to at least one transceiver, 204-210. While four transceivers are shown in this illustration, this is not meant to limit the number of transceivers that the processor 202 may be linked to. The transceivers 204-210 are each associated with one or more links with neighboring nodes. Each link comprises at least one transceiver, and a transceiver may be part of more than one link. In certain embodiments, multiple transceivers will operate as a transceiver team, for example as a multi-input